Claims

1. A nucleic acid oligomer modified by covalently attaching a redox-active moiety, characterized in that the redox-active moiety comprises one or more electron-donor molecules and one or more electron-acceptor molecules.

2. The modified nucleic acid oligomer according to claim 1, characterized in that the redox-active moiety comprises at least one redox-active, linked, at least bimolecular electron-donor/electron-acceptor complex, at least two of the electron-donor molecule(s) and/or electron-acceptor molecule(s) of the redox-active moiety being joined with one another via one or more bonds.

3. The modified nucleic acid oligomer according to claim 2, characterized in that at least two of the electron-donor molecule(s) and/or electron-acceptor molecule(s) of the redox-active moiety are joined with one another via one or more covalent bonds.

4. The modified nucleic acid oligomer according to claim 1, characterized in that the redox-active moiety comprises at least one redox-active, linked, at least bimolecular electron-donor/electron-acceptor complex, at least two of the electron-donor molecule(s) and/or electron-acceptor molecule(s) being covalently joined via one or more branched or linear molecular moieties of any composition and chain length.

5. The modified nucleic acid oligomer according to claim 4, wherein the branched or linear molecular moieties have a chain length of 1 – 20 atoms, especially 1 – 14 atoms.

6. The modified nucleic acid oligomer according to one of the preceding claims, characterized in that the redox-active moiety comprising one

or more electron-donor molecules and one or more electron-acceptor molecules additionally comprises one or more macromolecules.

7. The modified nucleic acid oligomer according to one of the preceding claims, wherein the redox-active moiety is the native or modified reaction center of photosynthesizing organisms, especially the native or modified reaction center of photosynthesizing bacteria.

8. The modified nucleic acid oligomer according to one of claims 1 through 6, characterized in that one or more of the electron-donor and/or electron-acceptor molecule(s) are pigments, especially flavins, (metallo)porphyrins, (metallo)chlorophylls, or (metallo)bacteriochlorophylls, or derivatives thereof.

9. The modified nucleic acid oligomer according to one of claims 1 through 6, characterized in that one or more of the electron-donor and/or electron-acceptor molecule(s) are nicotinamides or quinones, especially pyrrolo-quinoline quinones (PQQ), 1,2-benzoquinones, 1,4-benzoquinones, 1,2-naphthoquinones, 1,4-naphthoquinones or 9,10-anthraquinones, or derivatives thereof.

10. The modified nucleic acid oligomer according to one of claims 1 through 6, characterized in that one or more of the electron-donor and/or electron-acceptor molecule(s) are charge transfer complexes.

11. The modified nucleic acid oligomer according to claim 10, wherein the charge transfer complex is a transition metal complex, especially a Ru(II), Cr(III), Fe(II), Os(II), or Co(II) complex.

12. The modified nucleic acid oligomer according to one of the preceding claims, wherein the modified nucleic acid oligomer can sequence-specifically bind single-strand DNA, RNA, and/or PNA.

13. The modified nucleic acid oligomer according to claim 12, wherein the modified nucleic acid oligomer is a deoxyribonucleic acid

oligomer, a ribonucleic acid oligomer, a peptide nucleic acid oligomer, or a nucleic acid oligomer having a structurally analogous backbone.

14. The modified nucleic acid oligomer according to one of the preceding claims, wherein, alternatively, the redox-active moiety is covalently bound to one of the phosphoric-acid, carboxylic-acid, or amine groups, or to a sugar, especially to a sugar-hydroxyl group, of the nucleic acid oligomer backbone.

15. The modified nucleic acid oligomer according to one of claims 1 through 13, wherein, alternatively, the redox-active moiety is covalently attached to a thiol, hydroxyl, carboxylic-acid, or amine group of a modified base of the nucleic acid oligomer.

16. The modified nucleic acid oligomer according to claim 15, characterized in that the reactive thiol, hydroxyl, carboxylic-acid, or amine group of the base is covalently bound to the base via a branched or linear molecular moiety having any composition and chain length, the shortest continuous link between the thiol, hydroxyl, carboxylic-acid, or amine group and the base being a branched or linear molecular moiety having a chain length of 1 – 20 atoms, and especially of 1 – 14 atoms.

17. The modified nucleic acid oligomer according to one of claims 14 through 16, wherein the redox-active moiety is attached to an end of the nucleic acid oligomer backbone or to a terminal, modified base.

18. The modified nucleic acid oligomer according to one of the preceding claims, characterized in that the redox-active moiety is a photoinducibly redox-active moiety.

19. The modified nucleic acid oligomer according to one of claims 1 through 17, characterized in that the redox-active moiety is a chemically-inducibly redox-active moiety.

20. The modified nucleic acid oligomer according to one of the preceding claims, characterized in that multiple redox-active moieties are attached to the nucleic acid oligomer.

21. A method of producing a modified nucleic acid oligomer as defined in one of the preceding claims, wherein a redox-active moiety is covalently attached to a nucleic acid oligomer.

22. The method of producing a modified nucleic acid oligomer according to claim 21, wherein the redox-active moiety is attached to a nucleic acid oligomer by covalently attaching one or more electron-donor molecule(s).

23. The method of producing a modified nucleic acid oligomer according to claim 21, wherein the redox-active moiety is attached to a nucleic acid oligomer by covalently attaching one or more electron-acceptor molecule(s).

24. The method of producing a modified nucleic acid oligomer according to claim 21, wherein the redox-active moiety is attached to a nucleic acid oligomer by covalently attaching one or more macromolecules or by covalently attaching one or more proteins.

25. The method of producing a modified nucleic acid oligomer according to claims 22 through 24, wherein the redox-active moiety is completed by adding one or more electron-acceptor molecule(s), one or more electron-donor molecule(s), one or more macromolecules, and/or one or more proteins.

26. The method of producing a modified nucleic acid oligomer according to one of claims 21 through 25, wherein, alternatively, the nucleic acid oligomer is bound to the redox-active moiety by one or more amidations with amine or acid groups of the redox-active moiety, by one or more esterifications with alcohol or acid groups of the redox-active moiety, by thioester formation with thioalcohol or acid groups of the redox-active moiety,

or by condensation of one or more amine groups of the nucleic acid oligomer with aldehyde groups of the redox-active moiety and subsequent reduction of the resultant carbon-nitrogen double bond.

27. The method of producing a modified nucleic acid oligomer according to one of claims 21 through 26, wherein one or more branched or linear molecular moieties of any composition and chain length are covalently attached to the redox-active moiety and the branched or linear molecular moieties possess, alternatively, a reactive amine, hydroxyl, thiol, acid, or aldehyde group for covalent attachment to a nucleic acid oligomer.

28. The method of producing a modified nucleic acid oligomer according to claim 27, wherein the shortest continuous link between the nucleic acid oligomer and the redox-active moiety is a branched or linear molecular moiety having a chain length of 1 - 20 atoms, and especially of 1 - 14 atoms.

29. A modified conductive surface, characterized in that one or more types of modified nucleic acid oligomers according to one of claims 1 through 20 are attached to a conductive surface.

30. The modified conductive surface according to claim 29, wherein the surface consists of a metal or a metal alloy, especially a metal selected from the group: platinum, palladium, gold, cadmium, mercury, nickel, zinc, carbon, silver, copper, iron, lead, aluminum, manganese, and their mixtures.

31. The modified conductive surface according to claim 29, wherein the surface consists of a semiconductor, especially a semiconductor selected from the group: carbon, silicon, germanium, and α-tin.

32. The modified conductive surface according to claim 29, wherein the surface consists of a binary compound of the elements of groups 14 and 16, a binary compound of the elements of groups 13 and 15, a binary

compound of the elements of groups 15 and 16, or a binary compound of the elements of groups 11 and 17, especially a Cu(I) halide or an Ag(I) halide.

33. The modified conductive surface according to claim 29, wherein the surface consists of a ternary compound of the elements of groups 11, 13, and 16, or a ternary compound of the elements of groups 12, 13, and 16.

34. The modified conductive surface according to claims 29 through 33, wherein the attachment of the modified nucleic acid oligomers to the conductive surface occurs covalently or by chemisorption or physisorption.

35. The modified conductive surface according to one of claims 29 through 34, wherein, alternatively, one of the phosphoric-acid, carboxylic-acid, or amine groups, or a sugar group, especially a sugar-hydroxy group of the nucleic acid oligomer backbone, is attached, covalently or by chemisorption or physisorption, to the conductive surface.

36. The modified conductive surface according to one of claims 29 through 34, characterized in that, alternatively, a thiol, hydroxyl, carboxylic-acid, or amine group of a modified base of the nucleic acid oligomer is attached, covalently or by chemisorption or physisorption, to the conductive surface.

37. The modified conductive surface according to claim 35 or 36, wherein the modified nucleic acid oligomer is bound to the conductive surface via a group at the end of the nucleic acid oligomer backbone or via a group of a terminal, modified base.

38. The modified conductive surface according to claims 29 through 37, wherein branched or linear molecular moieties of any composition and chain length are attached, covalently or by chemisorption or physisorption, to the conductive surface and the modified nucleic acid oligomers are covalently attached to these molecular moieties.

39. The modified conductive surface according to claim 38, wherein the shortest continuous link between the conductive surface and the nucleic acid oligomer is a branched or linear molecular moiety having a chain length of 1 – 20 atoms, and especially of 1 – 12 atoms.

40. The modified conductive surface according to claim 38 or 39, wherein, alternatively, the branched or linear molecular moiety is attached to a phosphoric-acid, carboxylic-acid, or an amine group, or a sugar group, especially a sugar-hydroxyl group, of the nucleic acid oligomer backbone, or a thiol, hydroxyl, carboxylic-acid, or amine group of a modified base of the nucleic acid oligomer.

41. The modified conductive surface according to claim 40, wherein the branched or linear molecular moiety is bound to a phosphoric-acid, sugar-hydroxyl, carboxylic-acid, or amine group at the end of the nucleic acid oligomer backbone or to a thiol, hydroxyl, carboxylic-acid, or amine group of a terminal, modified base.

42. The modified conductive surface according to one of claims 29 through 41, characterized in that predominantly one type of modified nucleic acid oligomer each is attached in a spatially delimited area of the conductive surface.

43. The modified conductive surface according to one of claims 29 through 41, characterized in that only one type of modified nucleic acid oligomer each is attached in a spatially delimited area of the conductive surface.

44. A method of producing a modified conductive surface as defined in claims 29 through 43, characterized in that one or more types of modified nucleic acid oligomers are applied to a conductive surface.

45. The method of producing a modified conductive surface as defined in claims 29 through 43, characterized in that one or more types of

nucleic acid oligomers are applied to a conductive surface and, thereafter, a modification of the nucleic acid oligomers is carried out using a method according to claims 21 through 28.

46. The method of producing a modified conductive surface according to claim 44 or 45, wherein the nucleic acid oligomers or the modified nucleic acid oligomers are hybridized with the respective complementary nucleic acid oligomer strand and applied to the conductive surface in the form of the double-strand hybrid.

47. The method of producing a modified conductive surface according to claim 44 or 45, wherein the nucleic acid oligomer or the modified nucleic acid oligomer is applied to the conductive surface in the presence of further chemical compounds that are likewise attached to the conductive surface.

48. A method of electrochemically detecting oligomer hybridization events, characterized in that one or more modified conductive surfaces as defined in claims 29 through 43 are brought into contact with nucleic acid oligomers and, subsequently, detection of the electrical communication between the redox-active moiety and the respective conductive surface takes place.

49. The method according to claim 48, wherein detection takes place by cyclic voltammetry, amperometry, or conductivity measurement.

50. The method of electrochemical detection according to claim 48 or 49, characterized in that electrochemical detection is initiated by photoinduced charge separation in the photoinducibly redox-active moiety attached to the conductive surface via a nucleic acid oligomer.

51. The method according to claim 50, wherein the light irradiation for photoinduced charge separation in the photoinducibly redox-active moiety attached to the conductive surface via a nucleic acid oligomer is limited to an

area of the conductive surface having one or more modified nucleic acid oligomer types.

52. The method according to one of claims 50 or 51, wherein the photoinducibly redox-active moiety's oxidized electron-donor molecule or reduced electron-acceptor molecule resulting from irradiation with light of a specific or any given wavelength is rereduced or reoxidized by a suitable free redox-active substance not bound to, but in contact with the nucleic acid oligomer, i.e. the oxidized electron-donor molecule or reduced electron-acceptor molecule is restored to the state it was originally in prior to light irradiation.

53. The method of electrochemical detection according to claim 48 or 49, characterized in that the electrochemical detection is facilitated by a free redox-active substance that effectuates a chemically induced charge transfer to the redox-active moiety.

54. The method according to claim 52 or 53, wherein the free redox-active substance not bound to but in contact with the nucleic acid oligomer is selectively oxidizable and reducible at a potential φ, where φ satisfies the condition $2.0\ V \geq \varphi \geq -2.0\ V$, measured against normal hydrogen electrode.

55. The method according to one of claims 52 through 54, wherein the free redox-active substance not bound to but in contact with the nucleic acid oligomer is a free quinone, a free hexacyanoferrate(II) complex, a free sodium ascorbate, a free Ru(II)hexamine complex, or a free redox-active protein, especially a free cytochrome.